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U.S. PTO

Practitioner's Docket No. 5181-11401  
Client Docket No. P3051C

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

September 23, 1998

Assistant Commissioner for Patents  
Washington, D.C. 20231



BROADENING REISSUE APPLICATION TRANSMITTAL

Transmitted herewith is the application for reissue of U.S.

☒ Utility Patent ☐ Plant Patent ☐ Design Patent

Patent No.: 5,559,995

Issue Date: September 24, 1996

Inventor(s): Dan D. Browning, Ethan D. Joffe, and Jaron Z. Lanier

Title: METHOD AND APPARATUS FOR CREATING A WIREFRAME AND  
POLYGON VIRTUAL WORLD

Enclosed are the following:

1. Specification, claim(s) and drawing(s) (37 C.F.R. § 1.173).
  - (a) ☒ 4 page(s) of specification ( 324 pages of appendix)
  - ☒ 16 page(s) of claims (with newly added broadening claims underlined)
  - ☒ 1 page(s) of abstract

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CERTIFICATION UNDER 37 C.F.R. § 1.10\*  
(Express Mail label number is mandatory.)  
(Express Mail certification is optional.)

I hereby certify that this Reissue Application Transmittal and the documents referred to as enclosed therein are being deposited with the United States Postal Service on this date September 23, 1998, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL088046101US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Roger Combs

(b) ☐ \_\_\_\_\_ sheet(s) of drawing (drawings amended)

☐ Formal

☐ Informal

☒ No changes in the drawings, upon which the original patent was issued, are to be made. Therefore, in accordance with 37 C.F.R. § 1.174(a), please find attached, in the size required for original drawings:

☒ 3 sheets of copied printed drawings from the patent.

☐ a photoprint of the original drawings.

☐ A letter requesting transfer of the drawings from the original patent file to this reissue application is attached

2. Declaration and power of attorney

☐ \_\_\_\_\_ pages of declaration and power of attorney

3. Preliminary amendment

☐ Attached

4. Offer to surrender the original letters patent in accordance with 37 C.F.R. § 1.178:

☐ Offer to surrender is by the inventor

☐ along with assent of assignee.

☐ Offer to surrender is by the assignee of the entire interest (and the reissue application does not seek to enlarge the claims of the original patent).

5. Letters patent

☐ Original letters patent are attached.

☐ Declaration that original letters patent lost or inaccessible is attached.

☒ A copy of the original printed patent is attached.

6. Petition to proceed without assignee's assent

☐ Attached hereto is a "PETITION TO PROCEED WITH REISSUE APPLICATION WITHOUT ASSIGNEE'S ASSENT".

A. ☐ The fee payment is authorized in the attached:

☐ "REISSUE APPLICATION TRANSMITTAL" Form

☐ "COMPLETION OF FILING REQUIREMENTS - REISSUE APPLICATION" Form.

B. ☐ Payment is authorized below.

7. Information Disclosure Statement

- ☐ Attached
- ☐ Copies of the IDE citation(s) is/are attached.

8. Priority - 35 U.S.C. § 119

- ☐ Priority of application Serial No. 0 / \_\_\_\_\_, filed on \_\_\_\_\_  
in \_\_\_\_\_ is claimed under 35 U.S.C. § 119.  
Country
- ☐ The certified copy has been filed in prior application Serial No. 0 /  
\_\_\_\_\_ filed on \_\_\_\_\_

9. Basic Filing Fee Calculation (37 C.F.R. § 1.16(h), (I) and (j))

CLAIMS AS FILED			
Number Filed	Number Extra	Rate	Basic Fee (37 C.F.R. 1.16(h))
Total Claims (37 C.F.R. 1.16(j))	108 - 20 (and also in excess of total claims in patent)	X \$22.00	\$790.00 \$1936
Independent Claims 37 C.F.R. § 1.16(i))	9 - 3 (number of inde- pendent claims in patent)	X \$82.00	\$574
Filing fee calculation			\$3300

10. Small Entity Status (if applicable)

- ☐ A statement that this filing is by a small entity is  
☐ attached.

Filing Fee Calculation (50% of above) \$ \_\_\_\_\_

11. Additional Fee Payments

- ☐ Payment is being made for "PETITION TO PROCEED WITH REISSUE  
APPLICATION WITHOUT ASSIGNEE"  
(37 C.F.R. § 1.17(h)).....\$130.00

12. Total Fees Due

Filing Fee	\$ 3300
Petition Fee	\$ _____
Total Fees Due	\$ 3300

13. Method Of Payment of Fees

☒ Enclosed is a check in the amount of \$ 3300.

☐ Charge Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_.  
A duplicate of this request is attached.

14. Authorization To Charge Additional Fees

☒ If any fees are due, the Commissioner is authorized to charge said fees to  
Conley, Rose, & Tayon, P.C. Deposit Account No. 03-2769/5181-11401/DRC.

15. Additional Enclosures

Respectfully submitted,



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Date: September 23, 1998

PATENT  
5181-11401  
P3051C

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\_\_\_\_\_  
Roger Combs

Method and Apparatus for Creating a Wireframe and  
Polygon Virtual World

Reissue Application for United States Patent No. 5,559,995, issued on September 24, 1996

By:

Dan D. Browning  
Ethan D. Joffe  
Jaron Z. Lanier

# METHOD AND APPARATUS FOR CREATING A WIREFRAME AND POLYGON VIRTUAL WORLD

This is a continuation of application Ser. No. 07/621,474  
filed Nov. 30, 1990, now abandoned.

## BACKGROUND OF THE INVENTION

This invention relates to virtual reality systems and, more particularly, to a method and apparatus for creating a virtual world from a database containing a limited pictorial representation of the virtual world.

Users of computer systems are now able to create virtual realities which they may view and interact with. One type of virtual reality system is disclosed in U.S. patent application Ser. No. 08/133,802, filed Oct. 8, 1993, which is a continuation of U.S. patent application Ser. No. 07/535,253, filed Jun. 7, 1990, now abandoned, entitled "Virtual Reality Network," the disclosure of which is incorporated herein by reference. One task which must be performed is the creation of the virtual worlds within which the users interact. This can be a very tedious task, since a complete description of all virtual objects in the virtual world, including their constraints of motion, hierarchy, color, texture and other attributes must be made and entered into the virtual reality computer. Thus, it would be desirable to make virtual world creation as simple as possible.

## SUMMARY OF THE INVENTION

The present invention is a method and apparatus for creating virtual worlds wherein a user may begin with a database containing a limited pictorial representation of a desired virtual world and then edit the database to specify the remaining data needed to create the actual virtual world. In one embodiment of the present invention, a database containing a limited pictorial representation of a virtual world is communicated to a receiving unit, and a grouping unit collects various descriptions of the pictorial representation into selected groups. An attribute assigning unit then assigns attributes to the groups. The attributes may include group hierarchy, constraints of motion, color, texture or other features. The modified database is then communicated to a data coupling unit which couples real world data to the groups. Finally, a rendering unit renders the virtual world which looks and functions according to the specified attributes and the real world data.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a particular embodiment of an apparatus for creating a virtual world according to the present invention.

FIG. 2 is a series of menus used in a computer implementation of the present invention to control receiving pictorial representations of objects, grouping objects and assigning attributes to objects in a virtual world;

FIG. 3A is a pictorial representation of two objects and a single connecting edge (indicated by the arrow) that connects the two objects; and

FIG. 3B is a grouped, sweep polygon object created from the pictorial representation of FIG. 3A after being grouped.

## BRIEF DESCRIPTION OF THE APPENDICES

Appendix 1 is a source code listing of a program used for creating a virtual world database according to the present invention;

Appendix 2 is a text description of the operation of the operation of the program entitled "Starch" listed in appendix 1;

Appendix 3 is a text description of the operation of the program entitled "Wringer" listed in Appendix 1; and

Appendix 4 is a text description of the overall steps used to create a virtual world according to the present invention.

## DESCRIPTION OF SPECIFIC EMBODIMENTS

### 1. Project Description

The Matis database conversion project enables the use of the Matis kitchen database in a virtual reality environment. To accomplish this, the Matis kitchen files are converted into the Isaac file format via RB2Swivel.

This conversion process has several steps. First, the Matis product files are edited, using the STARCH editor. The added editing information is stored in a GROUPING file which can be reloaded into the editor. Once the editing is complete, the product is converted into an RB2Swivel Script file. Once the products needed to construct a kitchen are in dm RB2Swivel format, the WRINGER program builds an RB2Swivel Script file containing the information necessary to make a virtual world. The RB2Swivel worlds are then loaded into Body Electric, along with the Body Electric Data Massagers (DMs) necessary to animate the word.

FIG. 1 shows a general outline of the conversion process. The GROUPING of the Matis database will be available for use on Sun Microsystems computers.

### 2. The STARCH Editor

This program runs on the SGI and enables the user to convert Matis product data into the GROUPING file data format. The final output format of the editor is RB2Swivel Script files. The GROUPING data file contains all the information necessary to edit a product from its last saved state. This information can also be used to speed the editing of similar products. Once editing is completed, the grouped Matis product data is converted temporarily to the SOAP data format. It is then converted to a Swivel Script file. There is one Swivel script file per product.

The editor provides file tools necessary for the grouping of matis graphic primitives into polygons or sweeps. Additional information such as constraints, thickness, and color can then be added.

#### 2.1 Product Selection

The user needs to select which product to edit. This is accomplished by entering either the product number or name, or by cycling through the list of products of a kitchen as contained in the Matis planfile.

There is one GROUPING file per product. If a product which has already been edited is reselected for editing, the user is asked to confirm his intentions.

#### 2.2 Default Parameter Addition

When a product is initially selected for conversion editing, default values for color, grouping, constraints, and thickness are added whenever possible.

Grouping defaults are a non-trivial problem. Currently, grouping is accomplished interactively. Future project phases may automate this process.

On completion of the grouping of graphic primitives into a part, a part name can be supplied by the user, or default to a predetermined value in order to establish constraint and thickness defaults.

Color, Thickness, and Constraint defaults are determined upon entry of a part name, such as door.

### 2.3 Product Editing

The grouping view also supports hierarchy editing. It displays an indented notation tree structure which specifies the Swivel linking constraints of the parts. The default relationship of the parts is a flat tree structure where every part is a child of the root (the product).

#### COLOR VIEW

This view displays the RGB color value of the current part.

The four functions which the editor must provide are the ability to group Matis graphic primitives and subprimitives into parts, edit product color information, determine physical constraints, and add part thickness. This is accomplished in a one screen editing environment consisting of 8 views:

#### MATIS GRAPHIC VIEW

This view displays the original Matis data as a 3-D rotatable wireframe object. This view is used for selection and feedback, but is not modifiable, except for the addition of user polygons and constraint origins.

#### MATIS TEXT VIEW

All of the graphic primitives which compose the product are displayed in this view in a text list format. The association of text to graphics is accomplished through the use of color and highlighting. Primitives which can be subdivided into subprimitives have menu entries representing the subprimitives.

#### Grouping Process

One or more primitives and subprimitives are selected. They are then grouped using the appropriate grouping menu item, at which time a part name can be supplied. This name then appears in the Grouping text view. When the one or more primitives and subprimitives are grouped, either a polygon or a wireframe part is generated as the result. If the definition of the polygon is not planar, it will be grouped as a sweep polygon automatically. A sweep polygon is defined by two sets of lines and arcs, each element in one set is parallel to a mirror image element in the other set, and the sets are connected by a single edge describing the thickness. Sweeps may also be created implicitly, as part of a thickened polygon.

Two objects in a virtual reality world may be assigned as connected hierarchically. The hierarchy is created by selecting an object and designating it as a child object of another object.

Objects additionally can be assigned as rotatable about a portion of another object. This is necessary only if the part is unconstrained in some way. For instance, a door needs to rotate about one of its edges. To define a rotational constraint of motion for an object, the edge about which an object will rotate is selected. The origin will be set to the center of the edge if a line segment is selected, or the origin will be set to the center point of the defining endcap of a column if a column is selected. For example, to allow a faucet arm to swing side to side, an origin must be specified, and then the



minimum and maximum constraint values must be set. Once an object or a grouped object has been designated as rotatable about an origin, a change in an angle of rotation will cause the selected object to rotate about the origin by the specified amount.

#### GROUPING TEXT VIEW

This view contains a list of the part names of the currently grouped parts. When one of the names is selected, the primitives which compose the part will become selected.

#### THICKNESS VIEW

This view consists of editable text items which enable thickness to be added to the currently selected part. The editable items are height and height type. The height is the measurement by which to thicken the selected part in the direction of its normal vector. The height type specifies whether the thickness is added to the positive direction, negative direction, or equally distributed.

#### CONSTRAINTS VIEW

This view displays positional and rotational constraints of the currently selected part. It displays the current, minimum, and maximum constraint values, as well as lock status.

#### CONVERSION (SOAP) VIEW

This view displays the most recently convened state of the product. The product is displayed in shaded, polygonal format.

#### COLOR GRID VIEW

This view displays a color grid from which to interactively specify a grouping's color. This view only appears in Soap Edit mode, as described in the Starch User's Manual, Section 4.4, and replaces the Matis Graphic View.

### 3. The WRINGER World Constructor

This module constructs a kitchen as determined by the Matis index and plan files. Its one interaction with the user is to select a particular kitchen to build. A master Swivel script file is output by this module and is ported to the Macintosh, and loaded into RB2Swivel.

#### 3.1 Kitchen Selection

The user can input the index file entry number or the managing number as a command line argument when running the module. Wall, floor, and ceiling colors may also be specified by creating a "wringer.color" file. See the Wringer User's Manual for more details.

#### 3.2 Making a World

The plan file referenced by the index file entry is loaded. A new RB2Swivel script file is then written. As each wall is created, its products are located upon it as specified by the plan file. The file includes a head and hand, and initial world orientation information.

#### 4. Body Electric Interaction

DMs are defined for each type of movement that might be needed. They are then loaded by BE by indexing off the key part names in each product. This loading process occurs automatically when a world is loaded into BE.

[54] **METHOD AND APPARATUS FOR CREATING  
A WIREFRAME AND POLYGON VIRTUAL  
WORLD**

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[73] **Assignee:** VPL Research, Inc., Redwood City,  
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[21] **Appl. No.:** 939,834

[22] **Filed:** Sep. 2, 1992

**Related U.S. Application Data**

[63] **Continuation of Ser. No. 621,474, Nov. 30, 1990, abandoned.**

[51] **Int. CL.<sup>6</sup>** ..... **G06F 9/455**

[52] **U.S. CL.** ..... **395/500; 395/119; 395/133**

[58] **Field of Search** ..... **395/500, 600,  
395/700, 100, 119, 133**

[56] **References Cited**

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Fisher et al., "Virtual Environment Display System", ACM  
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*Primary Examiner*—William M. Treat

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5,559,995

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# APPENDIX 1

# MATIS VIRTUAL REALITY SPECIFICATION

**Version 1.1**

### Status Report

This document specifies the state of project implementation.

#### **Starch**

Matis products are fully readable by Starch.

#### **Groupings Files**

- Products can be edited, re-edited, and the grouping information can be reused for nearly identical products.

#### **Swivel Scripts**

- Swivel scripts are fully generated as part of the conversion process.

#### **Product Selection**

- Products may be selected by supplying a full name or index number, or by using the function keys as described in the Starch User's Manual, Section 4.1.

#### **Default parameter addition**

- Group defaults can be inherited when a group is named.

#### **Product Editing**

- The Matis Graphic View is up to Spec.
- The Matis Text View is up to Spec. The text view is scrollable, so long primitive lists can be fully viewed or selected.
- The Grouping Process is complete. Polygons are automatically made into *sweeps* if they are nonplanar.
- The Grouping Text view is up to Spec and is scrollable.
- The Color View is up to Spec. Currently colors are specified by RGB values, or interactively with the Soap Edit mode color grid.
- The Thickness View is complete. Polygons can be thickened by numeric or subprimitive input. Widening is achieved with wireframes (see Starch User's Manual, Section 4.3.).
- The Constraints view is up to spec.
- The Segmentation View has been incorporated into Soap Edit mode as a menu item.
- The Conversion (Soap) View is complete.
- A Polygon editor has been added to Starch. This editor allows previously undefined polygons to be created from available endpoints and from the length and direction of available edges. Drawers may now be converted.

with `stuffit 1.5.1`, also on this diskette. This version of Swivel allows for 3072 objects, and is used for all operations.

**Swivel Script & Binary Support Files:**

**Disk 1 of 2: SWIVBIN**

This diskette contains the folder `GOLDBIN`, compressed into the file `GOLDBIN.sit`. The compressed file must be decompressed with `stuffit 1.5.1`, also on this diskette. The folder `GOLDBIN` contains all of the Swivel binary files for the sample kitchen.

**Disk 2 of 2: SWIVSCRIPT**

This diskette contains the folder `GOLDSCRIPT`, compressed into the file `GOLDSCRIPT.sit`. The compressed file must be decompressed with `stuffit 1.5.1`, also on this diskette. The `GOLDSCRIPT` folder contains the original Swivel script files generated by Starch for the sample kitchen.

**KITCHEN PLAN (Swivel binary and Isaac files)**

**Disk 1 of 1: KITCHEN**

This diskette contains files `A2941A` and `A2941A.isaac`, compressed into files `swv.sit` and `isaac.sit` respectively. The compressed files must be decompressed with `stuffit 1.5.1`, also on this diskette. These files are the Swivel binary and `isaac` files for the sample kitchen. The script file `A2941A.swv` is included on the `SWIVSCRIPT` diskette.

**Gold Release**

Send FTP Command

After the ftp> prompt in the IRIS window, type these FTP commands:

```
prompt
mput *.SWV
```

These files will then be transferred to the Macintosh. There is a bug in Telnet which prepends a "/" to every file. In the Finder, from the view menu, select

by Name

Then select each afflicted file in the Swivel folder and delete these characters. This actually doesn't take too much time. (!)

#### IX. SWIVEL CONVERSION

Double click on the RB2Swivel icon from the Finder. In the File menu (found on the top bar), select

Open Command File

and specify the folder and filename to be read in. For the purposes of our demo, the filename will be

A51SK.SWV

Swivel then reads in and converts the script file. The Swivel binary is automatically saved to the current directory by the Swivel script.

No editing in Swivel should be necessary.

After the Swivel binary file is written, exit Swivel by selecting

Quit

from the File menu entry on the top bar. Alternately, you can select

Open Command File

to convert the next product.



To apply a color to the entire faucet, press <Shift> while selecting all the groups from top to bottom in the Group Text View. Then, in the color grid window, select the color of your choice. You may select from the grid, or from either of the color ramps\*\*. The current color is displayed in the lower left hand corner of the color window. Notice that the current color's RGB components are displayed in the righthand COLOR view. Finally, select

Set Color

from the Soap Menu. The color in the lower left hand corner of the color window will be applied to the groupings. Alternately, select a grouping and then

Get Color

to set the current color to the color of the selected grouping. Then select another grouping and apply that color with Set Color.

\*\* There are two ramps in the color window. The lefthand vertical ramp is a linear interpolation between the selected grid color and its grid neighbors to the top and to the bottom. The bottom horizontal ramp is a linear interpolation between the selected grid color and its neighbors to the left and to the right.

To exit Soap Edit mode, select

Soap Exit

from the Soap Menu. The Matis Graphics View reappears.

## **VII. SAVING AND EXITING**

From the Matis Menu, select

File Menu ->

and then

Save Groupings

A dialogue box appears: